HYDRODYNAMIC BEARING ARRANGEMENT

Description of Invention

The present invention relates to a bearing, in particular to a hydrodynamic bearing arrangement in which liquid is allowed to flow between two relatively rotating parts.

Hydrodynamic bearing arrangements in which a fluid is allowed to flow between two relatively rotating parts, the fluid supporting one part relative to the other, are known.

According to a first aspect of the invention we provide a hydrodynamic bearing arrangement for a rotatable shaft, the arrangement including a housing in which is provided a shaft support with an opening through which the shaft extends, there being a space between the shaft support and the shaft, the shaft support including at least one passage therethrough which extends generally axially of the shaft from a first side of the shaft support to a chamber provided in the housing at a second side of the shaft support so that liquid at the first side of the shaft support may communicate with the chamber at the second side of the shaft support and thus pass into the space between the shaft and the shaft support from both the first side of the shaft support and from the second side of the shaft support via the passage and the chamber, the liquid between the shaft and the shaft support maintaining the space between the shaft and shaft support and providing a hydrodynamic bearing for the shaft.

By virtue of permitting fluid to enter into the space between the shaft and the shaft support from both the first and second sides of the shaft support, the efficiency of the bearing arrangement may be increased.

Preferably, the shaft is the drive shaft of a pump, and the fluid at the first side of the shaft support is pumped fluid.

In this case, a pump impeller may be mounted on the shaft at the first side of the shaft support, and the shaft connected to a motor at the second side of the shaft support.

The shaft support may be provided with a plurality of generally axially extending passages which are arranged in an array around the shaft.

Preferably a seal is provided between the housing and the shaft to close the chamber and prevent leakage of fluid from the chamber.

The shaft support may include two generally annular support parts which are spaced axially along the shaft. In this case, the shaft may be provided with an annular plate which extends radially between the two support parts.

By virtue of the provision of the annular plate, axial movement of the shaft with respect to the housing may be substantially prevented.

Preferably there is a space between the annular plate and each of the support parts, and each support part includes two passages which extend generally parallel to the shaft, an outer one of which is located radially outwardly of the annular plate, and an inner one of which is located such that one end is adjacent to the annular plate.

Thus, fluid at the first side of the shaft support may flow through the outer passage in both support parts to the chamber at the second side of the shaft support, and through the inner passages from the first side of the shaft support and the chamber at the second side of the housing into the spaces between the annular plate and the shaft support parts, and the frictional forces between the plate and shaft support may be reduced.

Each shaft support may be provided with a plurality of inner passages and a plurality of outer passages which are arranged in two arrays around the shaft.

According to a second aspect of the invention we provide a pump including a housing enclosing a pumping chamber and a rotatable pumping part mounted in the pumping chamber on a drive shaft, the pump being provided

with a shaft support with an opening through which the drive shaft extends, there being a space between the shaft support and the drive shaft, the shaft support including at least one passage therethrough which extends generally axially of the drive shaft from the first side of the shaft support, which is in communication with the pumping chamber, to a secondary chamber provided in the housing at second side of the shaft support so that pumped fluid in the pumping chamber may communicate with the chamber at the second side of the shaft support and thus pass into the space between the drive shaft and the shaft support from both the first side of the housing and from the second side of the housing via the passage and the chamber, the liquid between the drive shaft and the shaft support maintaining the space between the drive shaft and shaft support and providing a hydrodynamic bearing for the drive shaft.

An embodiment of the invention will now be described with reference to the accompanying drawing which is an illustration of a section through a bearing arrangement according to the invention.

Referring to the figure, there is shown a hydrodynamic bearing arrangement 10 which in this example supports a drive shaft 12 of a fluid pump. The pump includes a housing 14 which encloses a pumping chamber and in which is provided a shaft support 16 with an opening through which the drive shaft 12 extends. The shaft support 16 extends from a first end within the pumping chamber to a second end adjacent the housing 14. An impeller 18 is mounted within the pumping chamber of the housing 14 on a first end 12a of the drive shaft 12, and a second end of the drive shaft 12 is connected to a motor (not shown) located outside the housing 14. Operation of the motor causes the drive shaft 12 to rotate about its longitudinal axis A, and the impeller 18 to rotate and effect pumping of fluid contained in the housing 14.

The housing 14 includes a generally circular aperture in which the shaft support 16 is mounted, a generally cylindrical retaining formation 20 extending inwardly and outwardly of the housing 14 surrounding the aperture.

The shaft support 16 in this example includes two generally annular support parts 16 and 16b, an inner one of which 16a is engaged with a part of the retaining formation 20a which extends into the pumping chamber, and an outer one of which 16b is engaged with a part of the retaining formation 20b which extends out of the pumping chamber. The outer part of the retaining formation 20b extends beyond the outer support part 16b, is provided with a sealing part 26 which extends radially inwardly of the aperture. The sealing part 26 engages with the drive shaft 12 to provide a substantially fluid tight seal between the drive shaft 12 and the housing 14 whilst still permitting rotation of the drive shaft 12 relative to the housing 14, and is of conventional design. A chamber thus is provided at the second end of the shaft support 16, enclosed between the sealing part 26, the outer retaining formation 20b and the outer support part 16b.

Each support part 16a, 16b includes a generally central circular aperture through which the drive shaft 12 extends, and a plurality of passages 22 which extend generally parallel to the longitudinal axis A of the drive shaft 12. The passages 22 are arranged in two arrays around the drive shaft 12 - an inner array 22a and an outer array 22b. In this example, eight passages are provided in each array 22a, 22b and are evenly spaced around the drive shaft 12 in a generally circular arrangement, the inner passages 22a being closer to the drive shaft 12 and of smaller diameter than the outer passages 22b.

The drive shaft 12 is provided with a generally annular plate 24 which extends radially outwardly of the shaft 12 between the two support parts 16a, 16b. The inner passages 22a each have an end adjacent to the plate 24, whereas the outer passages 22b are located radially outwardly of the plate 24. In this example, the drive shaft 12 is made of two parts which are joined by means of a screw thread arrangement located generally centrally of the portion of drive shaft 12 within the shaft support 16. The plate 24 is integral with first part 12a of the drive shaft 12, which carries the impeller 18, and the first part 12a, is

provided with a bore with an internal thread. A second part 12b of the drive shaft 12, which is connected to the motor, is provided with a corresponding externally threaded portion.

There is a space between the drive shaft 12 and the two support parts 16a, 16b, so that during operation of the pump, pressurised fluid within the pumping chamber is forced between the drive shaft 12 and the shaft support 16 to maintain the space and to provide a hydrodynamic bearing for the shaft 12. Pumped fluid is also forced along the passages 22 in the shaft support parts 16a, 16b from the first end to the second end of the shaft support 16.

Fluid flowing from the pumping chamber along the inner passages 22a in the inner support part 16a enters the space between the plate 24 and the inner support part 16a. Fluid flowing from the pumping chamber along the outer passages 22b in the inner support part 16a enters the space between the two support parts 16a, 16b and may then either pass into the spaces between the plate 24 and the support parts 16a, 16b or along one of the outer passages 22b in the outer support part 16b and into the chamber 28 at the second end of the shaft support 16. Fluid in the chamber 28 may flow into the space between the drive shaft 12 and the outer support part 16b or through the inner passages 22a of the outer support part 16b into the space between the plate 24 and the outer support part 16b.

Thus, pumped fluid in the spaces between the shaft support 16 and the drive shaft 12 and between the plate 24 and the shaft support 16 maintains these spaces and provides a hydrodynamic bearing between the relatively rotating parts. Such a hydrodynamic bearing may reduce frictional losses occurring during operation of the pump, and reduce wear of the drive shaft 12 and shaft support 16. As pumped fluid may enter these spaces from the first and second ends of the shaft support 16, the efficiency of the hydrodynamic bearing may be improved, and thus frictional energy losses and wear may be reduced further.

It will be appreciated that the above embodiment is described by way of example only, and numerous modifications may be made to the bearing arrangement within the scope of the invention.

For example, the shaft support 16 need not include two support parts 16a, 16b - one may suffice. Moreover, whilst the provision of a radially extending plate 24 is preferred as it limits axial movement of the drive shaft 12 with respect to the shaft support 16, it is not essential.

Whilst in this example the shaft support 16 is made separately from the pump housing 14, the shaft support 16 may instead be integral with the pump housing 14. Where the shaft support 16 includes a plurality of support parts 16a, 16b, one or more the support parts 16a, 16b may be integral with the housing 14.

It is, however, not necessary for the shaft support 16 to be provided in the housing 14 which encloses the pumping chamber. Instead, the shaft support 16 may be located separate from and outside the housing 14, with a conduit for pumped fluid being provided from the pumping chamber to the first side of the shaft support 16.

The shaft support part 16a and 16b, may each be made as a single part, the passages being formed by machining, for example, or in the part as cast. Alternatively, each support part 16a, 16b, may be made in two or more pieces, the passages being formed between appropriately shaped formations on adjacent pieces.

It is not necessary to provide a plurality of arrays of passages 22 in the shaft support 16 - one array could be sufficient, particularly where no plate 24 is provided, as in this case it is necessary only to direct fluid from the pumping chamber at the first end of the support to the chamber 28 at the second end of the support 16 so that the fluid can enter the space between the drive shaft 12 and the support 16 from both ends. Alternatively, in the embodiment shown above, it would be possible to omit the inner passages 22a and to rely on fluid

entering the space between the plate 24 and the support parts 16a, 16b from the space between the two support parts 16a, 16b and from the space between the drive shaft 12 and the support parts 16a, 16b to provide sufficient fluid for an adequate hydrodynamic bearing effect.

The hydrodynamic bearing arrangement described above need not be used to support the drive shaft of a pump. It may be used to provide a bearing for any rotatable shaft in which a supply of pressurised fluid is available.

A generally cylindrical, tubular bush may be mounted on each shaft support part 16am 16b between the shaft 12 and the support part 16a, 16b. In this case, the space for the fluid which provides the hydrodynamic bearing located between the shaft 12 and the bush, and the shaft 12 rotates in the bush. The bush may be provided with a plurality of recesses or apertures adjacent the shaft, which may act as reservoirs to retain fluid and therefore may assist in providing the hydrodynamic bearing.